Confidential

Design, Budget, and Timeline

Mini-Solar Power Station

SD1203

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1. Introduction

The Mini-Solar Power Station will consist of two subprojects. The first subproject will contain a satellite dish covered with a reflective surface aimed at the sun. The satellite dish will track the sun ensuring that the maximum amount of sun rays will be collected at all times. The reflective surface on the dish will focus all the sunlight to the dish's focal point. A hollow copper coil tube, which contains continuously running fluid, will be placed at the focal point. As the sunrays are reflected and focused at the copper coil tube, essentially at one point, the copper coil will begin to heat up which will consequently heat the fluid inside the coil. Thermal insulated tubing will connect the copper coil to a heat exchanger and a sterling engine, so that the heat from the liquid can be collected and transfer into kinetic energy. The sterling engine will drive an electrical generator. The heat will be converted to AC electricity and then converted to DC in order to charge two 12-volt batteries. The batteries will run an inverter, which can be a used as a power source for some common household appliances.

The second subproject includes constructing a mechanical fixture containing a heat/light source to simulate the rising, setting, and latitudinal movements of the sun. The fixture will be used in correspondence with the above-mentioned satellite dish. A high wattage heat lamp will be used to represent the sun and will be the source of heat. The heat lamp will include a dimmer switch, which will dim the heat lamp to represent cloud cover. Temperature data is to be collected and plotted in MatLab or LabVIEW. With the dimming of the lamp, the decrease in temperature should be evident in the MatLab or LabVIEW plotted data. The final goal of the project is to have the satellite mini-solar power station fully functional outside using natural sunlight.

2. Previous Work and Products

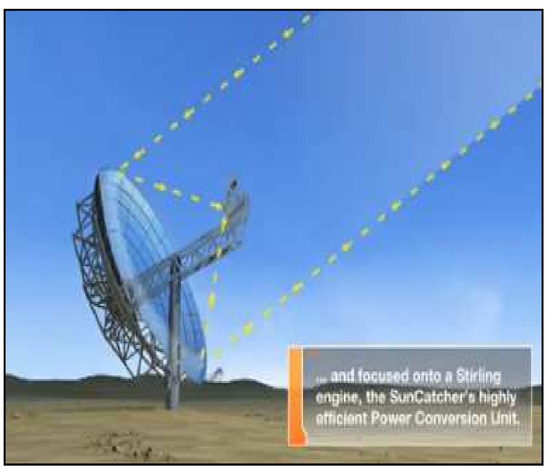
No previous NDSU work is similar to this design project. There are, however, patented products that hold similar features to that of our design.

2.1. **SunMachine**: SunMachine is a unique, small, company that designs and manufactures systems that convert heat to electricity. The following design generates heat from burning wood pellets. The heat is used to power a Stirling engine creating mechanical energy. The mechanical energy is converted to electricity using an inverter. The system produces 20% electricity and 70% heat producing an overall efficiency of 90%.

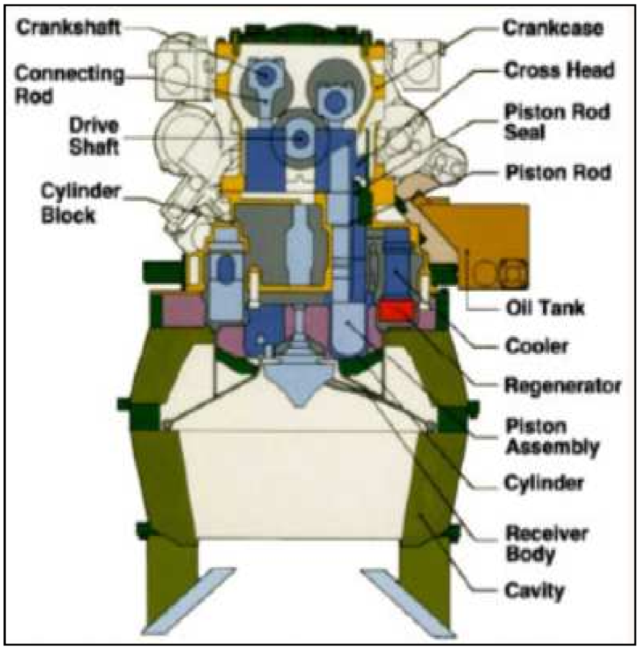
2.1.1. Stirling Engine: The Stirling engine used has one cylinder having a 31.73 cubic inch capacity with speed range of 500-1000 rpm. The engine uses nitrogen as working gas, and has a maximum working pressure of 580 PSI.

2.1.2. Inverter: The inverter uses an input voltage ranging from 350-750 Volts and has nominal output voltage of 3.4kW, providing a maximum efficiency of 95-97%. The peak capacity of the inverter is 3.8kW and it has a power factor of 0.997.

2.2. **The SunCatcher Solar Dish Stirling System**: The SunCatcher harnesses the suns energy by automatically tracking the sun and collect and focus solar energy on to a power conversion unit (PCU), which generate electricity. The SunCatcher is a 25-kilowatt-electric (kWe) solar dish Stirling system. Each dish has 82 mirrors, forming the dish shape, which focuses the light to an intense beam. The solar dish generates electricity by focusing the beam onto a receiver, which transmits the heat energy to a Stirling engine.

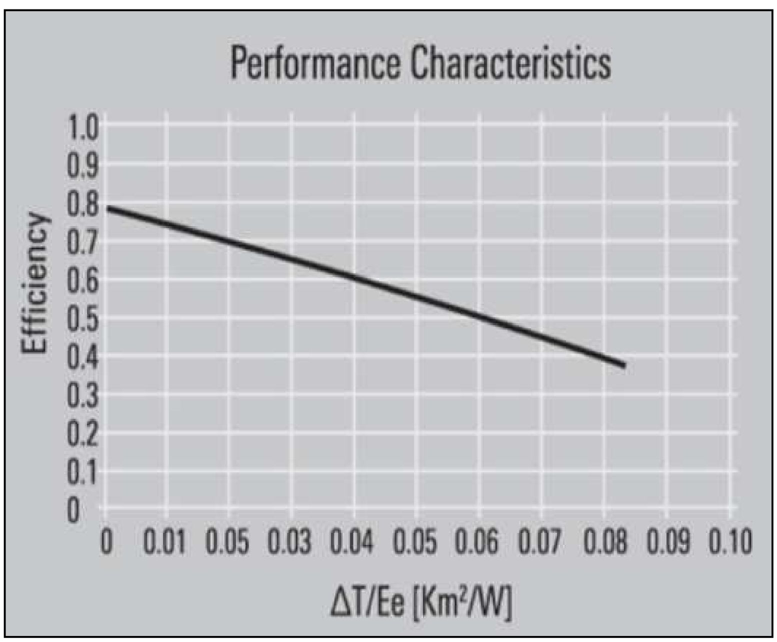


2.2.1. **Stirling Engine**: The Stirling engine uses hydrogen as a working gas. As the gas heats and cools, the pressure rises and falls driving the pistons inside the engine. This produces mechanical power, which is used to drive a generator and makes electricity.

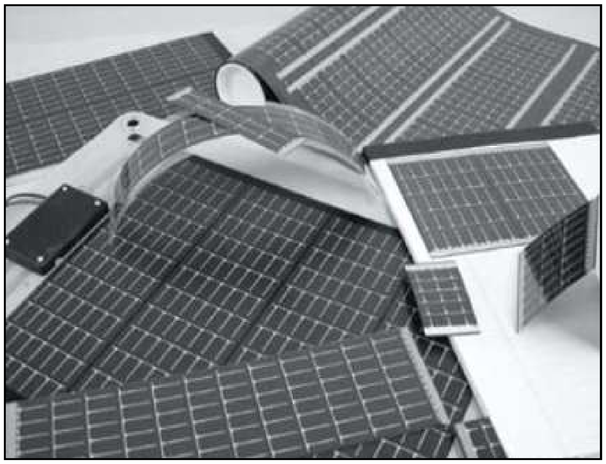


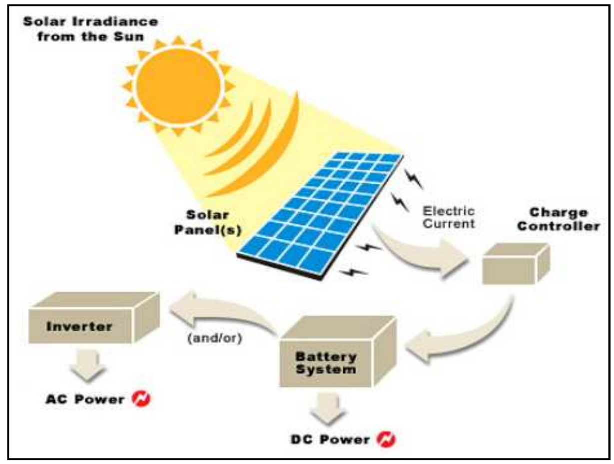
2.3. **Schuco Solar Thermal Collectors**: Thermal collectors turn solar radiation into heat by heating up a non-toxic liquid running through a serpentine copper pipe in the collector, which is transferred to the rest of the system.

2.3.1. Characteristics: The thermal collector has an output of 2.0kWth and an efficiency of 78.4%.



2.4. **PowerFilm**: These are flexible solar modules that are used to directly power devices requiring DC or they can be used as battery charger to store energy for later use. Multiple panels can be wired together to increase the voltage or current, and the panels can be cut to fit specific projects.





2.4.1. Characteristics: The particular panel shown in the left figure above can output 22mA at 3V, and has an open circuit voltage of 4.1V. The panel's total size is 2.5"x1.5" with a thickness of 0.22mm and only weighs a few grams.

2.5. **Patents**

2.5.1. Sun-tracking solar energy conversion system (patent number: US4223174)

2.5.1.1. Abstract: "A number of solar energy converter assemblies are carried by a support frame which is mounted for independent rotation about a horizontal and a vertical axis. Sensors detect the position of the sun; and control circuitry positions the support frame in elevation and azimuth so that the converter assemblies track and face the sun whenever the sun incident energy is greater than a threshold level of about 25 percent of normal. Each converter assembly includes a solar cell and a multi-angular conical concentrator shell for collecting, concentrating and directing incident solar energy onto the solar cell. The converter assemblies, the support frame and its mount, and the drive mechanism for the support frame are all located within a transparent stationary housing or enclosure, which provides complete environmental protection for all elements mounted within the enclosure."

Although our design does not include any solar cells, the concept of using sensors to detect the sun's position and then adjust our system accordingly is the same concept we plan to use in our design. We will also have the solar dish able to rotate about a horizontal and a vertical axis.

2.5.2. Passive solar heat collector (patent number: US4217882)

2.5.2.1. Abstract: "The present invention relates to a method and an improved passive apparatus for absorbing, transferring and storing solar energy as heat, economically and effectively, without pumps, solar tracking devices or electric power. The apparatus comprises an improved trough-type concentrating collector, a heat pipe heat absorber and an insulated storage tank. Solar energy is reflected and focused by the concentrator onto the absorber where the energy is absorbed as heat. The absorber, made of one or more slightly tilted gravity-assisted heat pipes partially filled with a volatile liquid, transfers the heat by evaporation, vapor transport and condensation into a slightly elevated heat storage reservoir. A method for filling the heat pipes is disclosed. The absorber serves as the main axial support for internal structural ribs over which are fitted a flexible transparent top cover and a flexible reflective bottom cover that comprise the concentrator. The apparatus collects solar energy, stores heat during the day

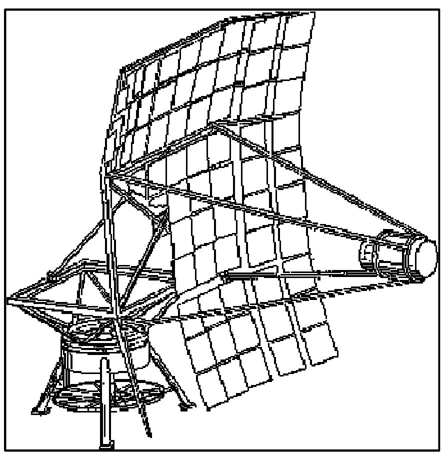
and automatically shuts off to minimize heat losses at night. The apparatus may be refocused periodically to increase the temperature of the heat collected."

This concept of collecting solar heat is also used in our design, although we will be using a solar dish to reflect and focus light instead of the trough-like structure described here. Another similarity between this idea and our idea is the capability to turn the device off during the night (or other times when it is more beneficial to be off than to be attempting to collect heat).

2.5.3. Matrix solar dish (patent number: US6485152)

Abstract: "A matrix solar dish concentrator with flexed glass mirrors is patterned from orthogonal planes parallel to the axis of symmetry of a paraboloid and intersecting the paraboloid, this pattern making all parabolic trusses uniform. Parabolic trusses are made by flexing linear truss members with lateral forces creating accurate parabolic member curves, restraining the flexed members with rigid webbing to form an orthogonal paraboloid frame. Parabolic glass mirrors are made by flexing slender flat glass mirrors with lateral forces creating accurate parabolic mirror curves, restraining the flexed mirrors with tension buttons connected to the orthogonal paraboloid frame to form a solar dish. Glass mirror structural substrates are not used. The solar dish tracks the solar azimuth with a bicycle wheel and tracks the solar zenith with a television satellite dish actuator. A solar receiver is supported with a low shade structure outside a cone of concentrated sunlight. Uniform flux is greater than 1000 suns and suitable for high-intensity photovoltaic cells and district heating systems."

Our design uses the idea of creating a very reflective surface and reflecting the sun's rays off of this surface to collect and use the heat it generates. Although this design is not circular like ours will be, there are similarities to be seen. See Image 1 below.



2.5.4. Low cost solar energy extraction (patent number: 7,481,057)

2.5.4.1. This patent is for a device to capture solar energy as heat and convert it to free energy using a collector surface that absorbs the solar radiation. Behind or under the collector surface is nozzles used to expand the hot air and convert some of its energy into kinetic energy. A turbine converts the remaining kinetic energy at the exit of the diffuser into rotational mechanical energy and/or electrical energy.

2.5.5. Solar Tracker (patent number: 7,799,987)

2.5.5.1. The solar tracker consists of a mounting surface to which a solar device is mounted allowing the device to change its orientation so as to be perpendicular to the sun's rays as the sun travels through an arc. A bendable mounting surface with an outer surface material that expands when exposed to water but not exposed to sunlight and contracts when exposed to sunlight that supports the mounting surface. The platform floats atop a water source, and the water source is in constant contact with outer surface so the capillary action causes the outer surface material to be saturated when it is not exposed to sunlight. The solar device is composed of a photovoltaic cell and a Fresnel lens held at a fixed position relative to the photovoltaic cell for concentrating sunlight on the photovoltaic cell. The solar tracker is composed of a Stirling engine and a concentrator for concentrating the sunlight to the Stirling cycle engine and an electrical generator connected to the Stirling cycle engine.

2.5.6. Outdoor solar collector and integrated display panel (patent number: 7,934,496)

2.5.6.1. Uses a solar panel to collect solar light and convert the solar light into heat. The heat will be available for heating and cooling applications, and for conversion into other forms of energy such as electricity. Also, this invention will provide a device which will collect solar energy and convert the solar light into heat, and also provide a flat surface upon which information and/or images may be presented.

2.5.7. Solar and wind energy converter (patent number: 7,851,935)

2.5.7.1. An energy generating system capable of converting wind and solar energy for use with an electrical generator. During the day, the system concurrently derives energy from both wind and solar energy sources. During the night, the system continuously harvests wind energy. Uses one or more solar collectors and external combustion engine including one or more Stirling engine.

2.5.8. Stirling engine and associated methods (patent number: 7,677,039)

2.5.8.1. The engine includes at least two fluid chambers, a displacer (which may be rotary), and a movable seal. At least one displacer may be included in each of the least two fluid chambers. The Stirling engine may include any one of at least one heat source, at least one heat sink, at least one converter, or any combination of any two or more of the preceding.

3. Design Options

3.1. Harnessing the Suns Energy

3.1.1. Solar Cells (Panel) or Solar Thermal Collectors Design

3.1.1.1. Advantage: Using solar panels or thermal collectors does not require any electrical energy or expenses to power them. Solar cells require little maintenance, mainly because there are no moving parts that must be maintained. Solar cells have been built to last a lifetime, so the solar station would pay great dividends. Solar cells and thermal collectors do not cause any environmental pollution other power systems. Installation and application of solar cells is easy, and they have wide ranges of uses.

3.1.1.2. Disadvantage: The overall process is fairly expensive because silver is used for interconnection of cells in the panel. Silver is the best conductor of electricity, having low resistance and silver increases efficiency. The electricity generated using this method is stored in storage batteries, which only offers direct current (DC). In order to use the electricity to

operate household appliances, for example, the DC would have to be converted to AC using an inverter. Although solar cells and thermal collectors have been around for some time and using them in our project, although still exciting and challenging, do not make a fairly unique and ingenious senior design project.

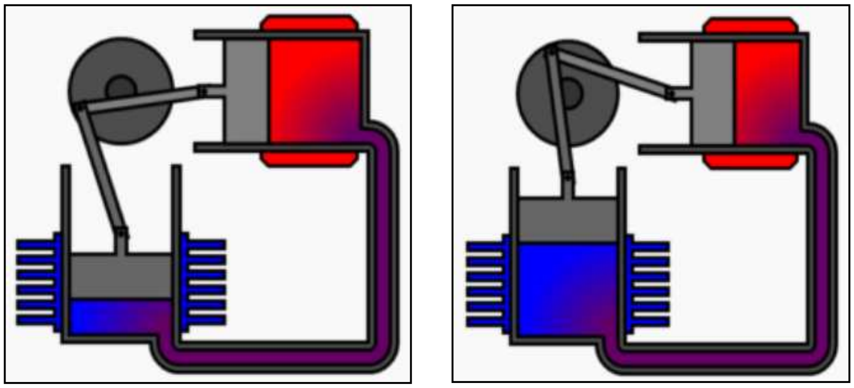
3.1.2. Converting heat to electricity using Stirling engine

3.1.2.1. Advantage: Compared to other engine types the Stirling engine has a silent operation because there is no expansion in the atmosphere like the internal combustion engine, is easy to balance, and generates few vibrations. The Stirling engine operates at a high efficiency because it is a function of the temperature of the hot and cold sources. There are a large number of heat sources including the combustion of gases, wood, sawdust, waste, and solar or geothermic energy. Has the ecological ability to reduce the environmental requirements on air pollution. The gases generated by the engine do not leave the engines casing, so there is not exhaust from this system. It has been known to be very rustic, having a long lifespan. There are few moving parts, limiting the wear on components. Because of the Stirling engines simply design, there is very little maintenance. Using the Stirling engine concept will provide the group with a fascinating, although not innovative, project that we will be proud to complete.

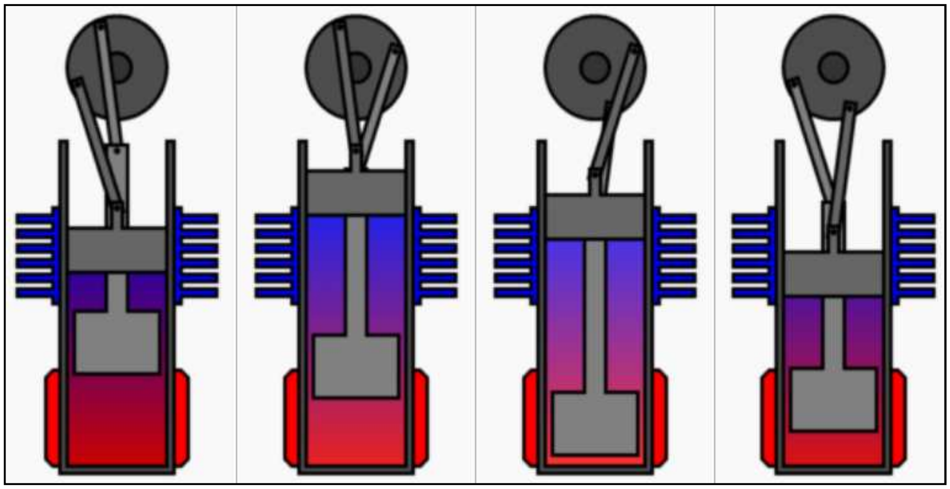
3.1.2.2. Disadvantage: The major disadvantage of using the Stirling engine is the high cost. There also exists the problem of sealing when high pressure of operation is needed. The ideal choice of gas is hydrogen because of its lightness and its capacity to absorb the calories, but its ability to diffuse through materials is hydrogen's disadvantage. There will also be minimal maintenance involved. The electricity generated using this method is stored in storage batteries, which only offers direct current (DC). In order to use the electricity to operate household appliances, for example, the DC would have to be converted to AC using an inverter.

3.2. Type of Stirling Engine – The Stirling engine is an external combustion engine allowing for a range of fuel sources. The heat supplied to the engine causes the working fluid inside the engine casing to expand, moving the piston. A dispatcher then transfers the fluid into the cold zone of the engine where it is recompressed by the working the piston. Then, the fluid returns to the hot region of the engine and the cycle repeats. The regenerator captures heat from the working fluid as it moves from the hot to cold part of the engine with the heat being given back to the fluid on the return. This process reduces the amount of fuel needed to reheat the working fluid. There are two major types of Stirling engines, distinguished by the way they move the air between the hot and cold spaces.

3.2.1. An Alpha Stirling engine has two power pistons in separate cylinders, one in the hot and one in the cold. The hot cylinder is inside a heat exchanger and the cold cylinder is inside a low temperature heat exchanger. The alpha Stirling engine has a high power-to-volume ratio, but has some technical problems because of the high temperature of the hot piston and the durability of its seals. The two figures below provide a general idea of the operation; however the heat exchangers, regenerator, and crankshaft are not shown.



3.2.2. A Beta Stirling engine has a single power piston arranged within the same cylinder on the same shaft as a displacer piston, which has a loose fit and does not extract any power from the expanding gas. The displacer piston only functions to shuffle the working gas from the hot heat exchanger to the cold heat exchanger. When the working gas is pushed from the hot end to the cylinder it expands and pushes the power piston. When the power piston is pushed to the cold end of the cylinder it contracts and the momentum of the machine pushes the power piston the other way to compress the gas. Once again, the general operation is shown in the figure below.



3.3. Sun Simulator Frame Material

3.3.1. Metal

3.3.1.1. Advantage: Designing the simulator frame using metal would ensure a secure and stable design. Either a flat metal tracking system, kind of like railroad tracks, or metal piping would be the frames infrastructure. Either of these designs would give us a smooth and even curve.

3.3.1.2. Disadvantage: Construction of the flat metal tracking system would be difficult and expensive, because the track would have to be cut out of a giant piece of metal. Metal piping would probably be cheaper, but would definitely require a metal fabricator to bend the piping to the desired shape. Although it would be nice to have a nice secure frame the large amount of weight would increase the size and capabilities of the stepper motor, which would increase cost.

3.3.2. PVC

3.3.2.1. Advantage: PVC would provide a lighter frame, but would still be secure and stable. The cost of PVC is cheap and it comes in numerous sizes, not to mention all the fittings (elbows and tees joints, and couplings) available for us to use.

3.3.2.2. Disadvantage: PVC is a hard plastic, so the cheapest way to bend it is to heat the PVC. Heating and bending PVC could put kinks in the PVC, which would be undesirable. After some research, the best way to accomplish this is to fill the PVC with sand before heating and bending. The sand evenly distributes the heat and helps prevent kinking. There is a product on the market called *PVC Bendit*, which can bend PVC into perfect curves. However, the kit ranges from $199.00-$629.00. Since this would be a one-time use and since the sun simulator is only testing the satellite tracking system, this large increase of budget would be undesirable for our group.

3.3.3. EMT – Electrical Conduit

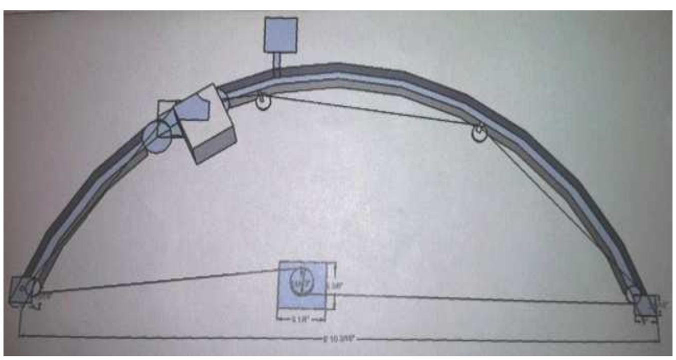
3.3.3.1. Advantage: EMT is cheap, more pliable than PVC, and still has characteristics of metal pipes. EMT is light generally made of coated steel or aluminum, so it would provide a smooth and secure surface for the simulator infrastructure. EMT is easy to bend, especially when using tools available to shape and curve EMT.

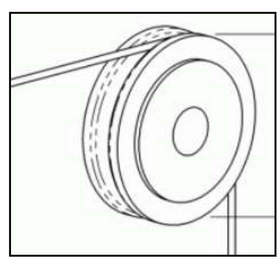
3.3.3.2. Disadvantage: EMT is a light thin-walled tube not meant to handle pressure or caustic media, its real purpose is to protect electrical lines. Although EMT is easy to bend, in order to get a smooth curve a bender from an electrician or metal fabricator would be needed.

3.4. Sun Simulator Design

3.4.1. Track and pulley

3.4.1.1. We believe this system will best serve our purpose. Construction will be study and fairly simply to construct. Most importantly, it will mimic the rising, setting, and latitudinal movements of the sun, providing a great sun simulation apparatus for the Satellite tracker to track.





3.5. Satellite Dish

3.5.1. A standard satellite dish would be easy to find and would be sufficient for the purpose of our project. The standard size dish is smaller and weighs less than larger dishes, which could make design and construction of the mechanical fixture simpler.

3.5.2. A max satellite dish is very similar to a standard satellite dish but has a larger dish surface area. A larger dish surface area would give us a larger surface area of sun collection which would

increase heat and electricity production. However, not significantly larger, the extra weight could pose some difficulties.

3.6. Reflective Surface of Satellite Dish

3.6.1. Mirrors are very reflective, however, applying a mirror or fragments of a mirror on the satellite dish would be challenging.

3.6.2. Space Blankets are cheap and are very reflective. Application of the space blanket would be simple.

3.7. Battery Selection - Our solar station will be battery powered. It needs batteries that are rechargeable because the solar station will be collecting energy from the sun, and the energy collected will be stored in two 12V batteries. The batteries must be safe in wet condition and must be able to be charged hundreds of times. Size is not an issue, although smaller batteries will reduce the overall size of the system. It also has to have a good price per AH rating, so that we get the most for our money.

3.7.1. SLA (Sealed Lead Acid)

3.7.1.1. Advantages

3.7.1.1.1. Good for poorly ventilated areas

3.7.1.1.2. No need to add water

3.7.1.1.3. Good for short periods of use

3.7.1.1.4. The price per AH is very good

3.7.1.1.5. Does not produce a lot of heat

3.7.1.1.6. Charges are cheap

3.7.1.1.7. Provides 200-300 charge cycles

3.7.1.2. Disadvantages

3.7.1.2.1. Should not be completely discharged

3.7.1.2.2. Slow charging (8+ hours)

3.7.2. Li-On

3.7.2.1. Advantages

3.7.2.1.1. Good in cold weather

3.7.2.1.2. Many charge cycles

3.7.2.1.3. Fast recharge times

3.7.2.2. Disadvantages

3.7.2.2.1. Expensive

3.7.2.2.2. Chargers can be expensive

3.7.3. Nickel Metal Hydride

3.7.3.1. Advantages

3.7.3.1.1. Fast recharge times

3.7.3.1.2. Moderately priced

3.7.3.2. Disadvantages

3.7.3.2.1. Get very hot during discharge

3.7.3.2.2. Chargers can be expensive

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4. Approach

After considering all of our design considerations up to this point, the following is a summary of our design approach. The Mini-Solar Power Station will consist of two subprojects, Sun Simulator and Satellite Tracker. The Satellite Tracker will contain a max satellite dish covered with a reflective Grabber Emergency Space Blanket. The satellite dish will track the sun ensuring that the maximum amount of sun rays will be collected at all times. The reflective surface on the dish will focus all the sunlight to the dish's focal point. A hollow copper coil tube, which contains continuously running water, will be placed at the focal point. As the sunrays are reflected and focused at the copper coil tube, essentially at one point, the copper coil will begin to heat up which will consequently heat the fluid inside the coil. Thermal insulated tubing will connect the copper coil to a heat exchanger and a sterling engine, so that the heat from the liquid can be collected and transfer into kinetic energy. The sterling engine will drive an electrical generator. The heat will be converted to AC electricity and then converted to DC in order to charge two 12-volt SLA rechargeable batteries. The batteries will run a 300-watt inverter, which can be a used as a power source for some common household appliances. Satellite motor operation will be controlled by a PIC microcontroller, which will be coded in C.

The Sun Collector's mechanical fixture will contain a heat/light source to simulate the rising, setting, and latitudinal movements of the sun. The fixture will be composed of ¾" EMT, a combination of pulleys, and stepper motors which will drive the heat bulb to mimic the suns movement. This system will work in correspondence with the above-mentioned Satellite Tracking system, and serves as a testing device to prepare the Satellite Tracker for operation outside. A 250W heat lamp will be used to represent the sun and will be the source of heat. The heat lamp will include a dimmer switch, which will dim the heat lamp to represent cloud cover. Both motor control and dimmer switch will be controlled by the PIC microcontroller. The microcontroller will be programmed in C.

The heat exchanger, Stirling engine, and inverter have not yet been determined because more research is needed. Real time temperature data will be collected and plotted in LabVIEW. With the dimming of the lamp, the decrease in temperature should be evident in the LabVIEW plotted data. The final goal of the project is to have the satellite mini-solar power station fully functional outside using natural sunlight.

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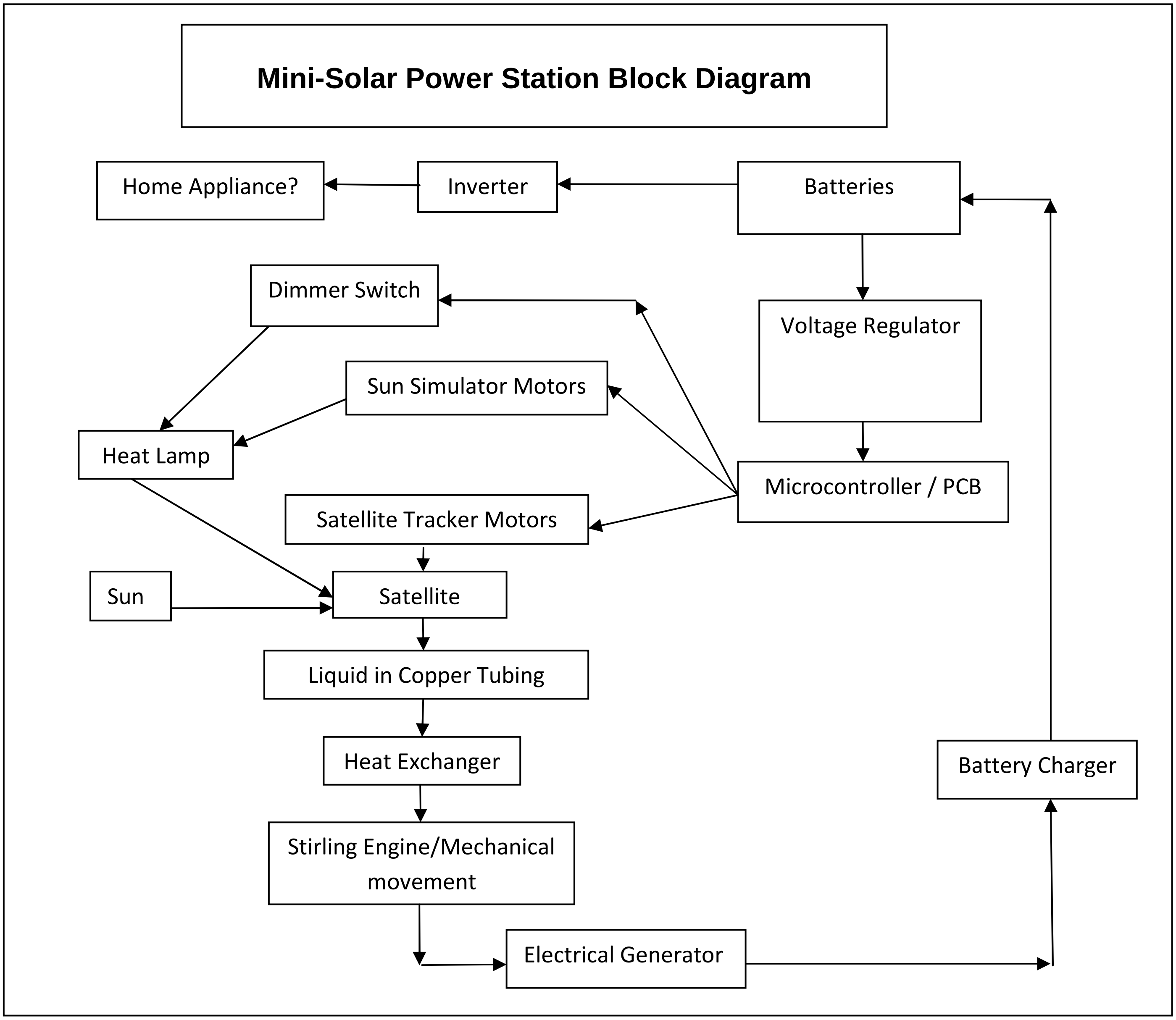

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5. Budget

The Mini-Solar Power Station is budgeted on a single sun simulator and satellite tracking system. The budget includes an approximate cost of expected materials and components used in our project, as well as a total approximation of the cost we expect to incur for this project.

Project Name:	Mini-Solar Power Station				
Project Number:	SD1203				
Sun Simulator					
Mechanical Hardware					
	Cost per Unit	Quinitity	Total Cost	Store/Supplier Part Number	Notes
3/4" - 10' EMT	$3.00	2	$6.00	Home Depot	
EMT Conduit Bender	$20.00	1	$0.00	Home Depot	
2'x10" - 10'	$7.97	2	$15.94	Home Depot	
4 in Heavy Duty Tee Hinge	$3.67	1	$3.67	Home Depot	Pair
Pearlco 250 W Heat Bulb	$22.49	1	$22.49	http://lllreptile.com	
Jung-L-Gym Heat Dome 8.5 in	$18.00	1	$18.00	www.sugargliderinfo.org	
Linear Actuator	$65.00	1	$65.00	Ebay	
57BYGH76-401A Stepper Motor	$60.00	1	$60.00	Ebay	Unipolar
Thomas & Betts EMT Coupling 3/4"	$3.24	1	$3.24	Sears	
Battalion cable pulleye, steel 3 in	$17.26	2	$34.52	Grainger Industrial Supply	
Satellite Tracking System					
Mechanical Hardware					
Sattelite Dish	$50.00	1	$0.00	Direct TV	
Circular Base for Dish (Metal)	$20.00	1	$0.00	Provided by Jace	Provided by Jace
Moon Blanket	$3.97	1	3.97	Home Depot	
57BYGH76-401A Stepper Motor	$60.00	2	$120.00	Ebay	Unipolar
5' Copper Pipe	$23	1	$23.00	Grainger Industrial Supply	
3' Insulated Plastic Tubing	$1.29	1	$1.29	Home Depot	
high speed stirling engine	$75.00	1	$75.00	Ebay	
12V battery	$20.00	2	$40.00	Ebay	
Electrical Components					
ZTX1053a (npn transistor)	$0.98	20	$19.60	DigiKey	
MCP602 (OPAMP)	$0.62	16	$9.92	DigiKey	
PIC18F4620 (Microcontroller)	$7.92	5	$39.60	DigiKey	
ECS-200-20-46X (20 MHz Crystal)	$0.46	5	$2.30	DigiKey	
PDV-P8105 (Photoresister)	$0.32	15	$4.80	DigiKey	
LM7805 (5V voltage regulator)	$0.61	5	$3.05	DigiKey	
LM7812ACT (12V voltage regulator)	$0.69	2	$1.38	DigiKey	
Estimated Actual Cost			$572.77		

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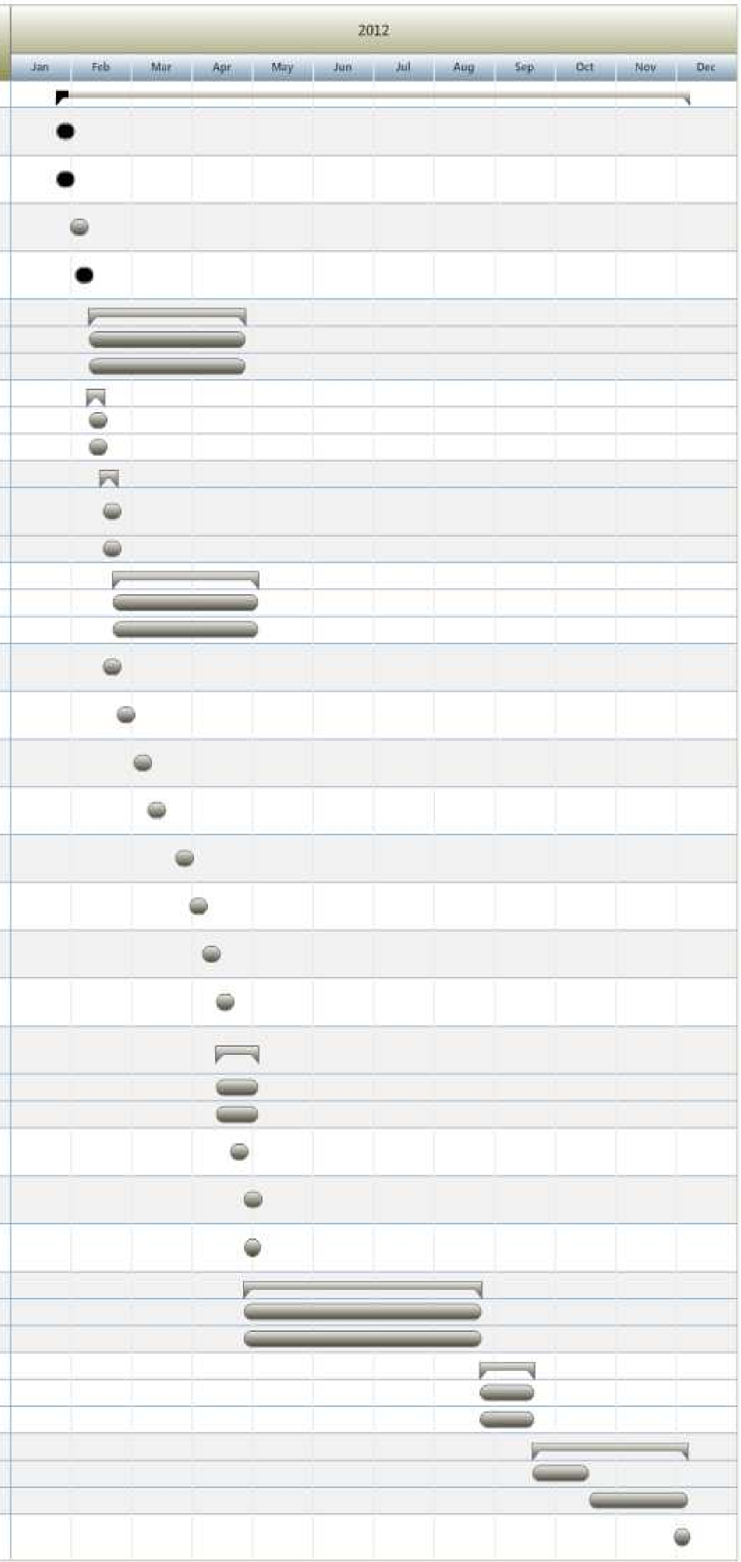
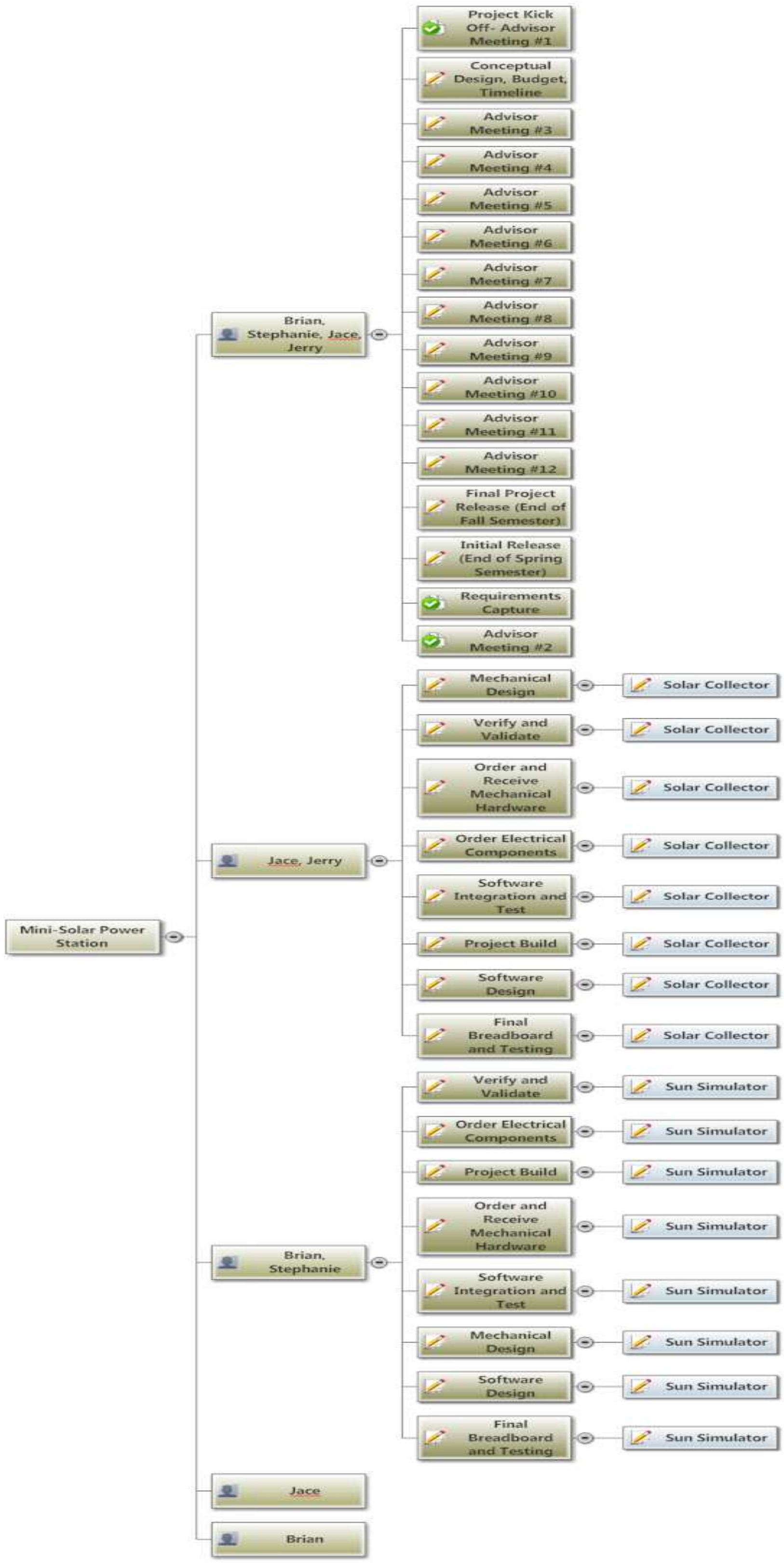
6. Timeline/Gantt Charts

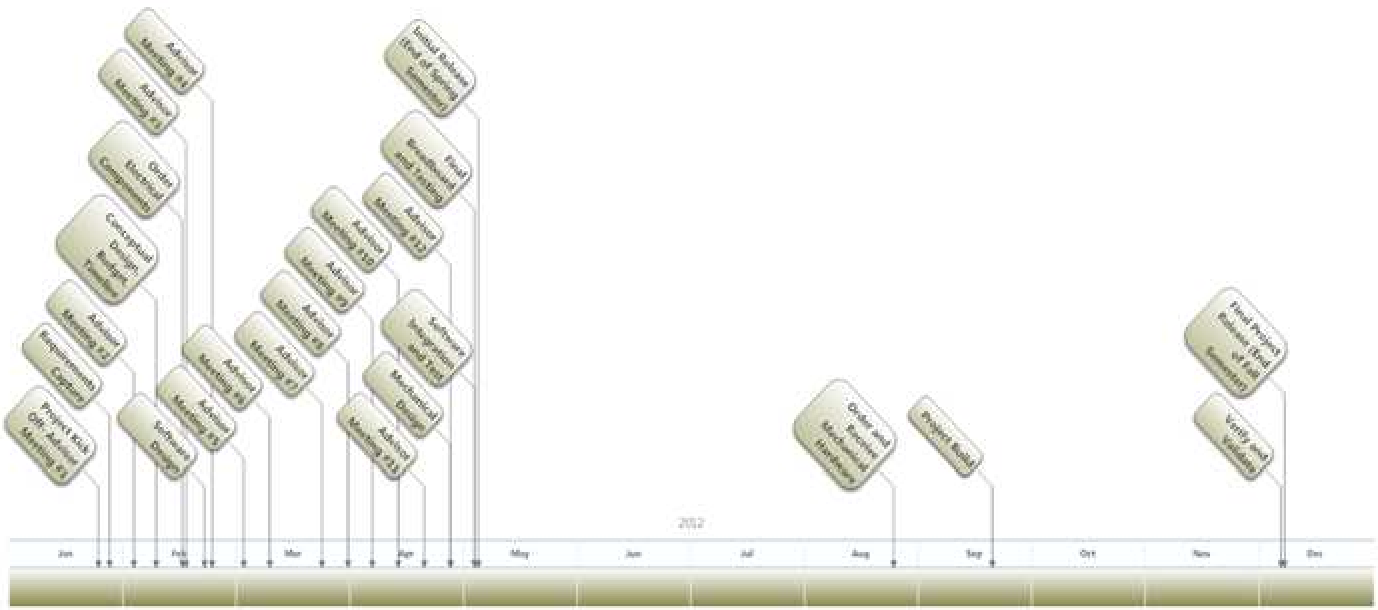
#	Task	Assigned To	Start	End	Dur
	Mini-Solar Power Station		1/24/12	12/7/12	229
1	Project Kick Off- Advisor Meeting #1	Brian, Stephanie, Jace, Jerry	1/24/12	1/24/12	1
2	Requirements Capture	Brian, Stephanie, Jace, Jerry	1/24/12	1/27/12	4
3	Conceptual Design, Budget, Timeline	Brian, Stephanie, Jace, Jerry	1/31/12	2/9/12	8
4	Advisor Meeting #2	Brian, Stephanie, Jace, Jerry	2/3/12	2/3/12	1
5	Mechanical Design		2/10/12	4/27/12	56
5.1	Solar Collector	Jace, Jerry	2/10/12	4/27/12	56
5.2	Sun Simulator	Brian, Stephanie	2/10/12	4/27/12	56
6	Order Electrical Components		2/10/12	2/16/12	5
6.1	Sun Simulator	Brian, Stephanie	2/10/12	2/16/12	5
6.2	Solar Collector	Jace, Jerry	2/10/12	2/16/12	5
7	Software Design		2/17/12	2/22/12	4
7.1	Sun Simulator	Brian, Stephanie	2/17/12	2/22/12	4
7.2	Solar Collector	Jace, Jerry	2/17/12	2/22/12	4
8	Software Integration and Test		2/22/12	5/3/12	52
8.1	Sun Simulator	Brian, Stephanie	2/22/12	5/3/12	52
8.2	Solar Collector	Jace, Jerry	2/22/12	5/3/12	52
9	Advisor Meeting #3	Brian, Stephanie, Jace, Jerry	2/17/12	2/17/12	1
10	Advisor Meeting #4	Brian, Stephanie, Jace, Jerry	2/24/12	2/24/12	1
11	Advisor Meeting #5	Brian, Stephanie, Jace, Jerry	3/2/12	3/2/12	1
12	Advisor Meeting #6	Brian, Stephanie, Jace, Jerry	3/9/12	3/9/12	1
13	Advisor Meeting #7	Brian, Stephanie, Jace, Jerry	3/23/12	3/23/12	1
14	Advisor Meeting #8	Brian, Stephanie, Jace, Jerry	3/30/12	3/30/12	1
15	Advisor Meeting #9	Brian, Stephanie, Jace, Jerry	4/6/12	4/6/12	1
16	Advisor Meeting #10	Brian, Stephanie, Jace, Jerry	4/13/12	4/13/12	1
17	Final Breadboard and Testing	Brian, Stephanie, Jace, Jerry	4/13/12	5/3/12	15
17.1	Sun Simulator	Brian, Stephanie	4/13/12	5/3/12	15
17.2	Solar Collector	Jace, Jerry	4/13/12	5/3/12	15
18	Advisor Meeting #11	Brian, Stephanie, Jace, Jerry	4/20/12	4/20/12	1
19	Advisor Meeting #12	Brian, Stephanie, Jace, Jerry	4/27/12	4/27/12	1
20	Initial Release (End of Spring Semester)	Brian, Stephanie, Jace, Jerry	5/4/12	5/4/12	
21	Order and Receive Mechanical Hardware		4/27/12	8/24/12	86
21.1	Sun Simulator	Brian, Stephanie	4/27/12	8/24/12	86
21.2	Solar Collector	Jace, Jerry	4/27/12	8/24/12	86
22	Project Build		8/24/12	9/20/12	20
22.1	Sun Simulator	Brian, Stephanie	8/24/12	9/20/12	20
22.2	Solar Collector	Jace, Jerry	8/24/12	9/20/12	20
23	Verify and Validate		9/20/12	12/6/12	56
23.1	Sun Simulator	Brian, Stephanie	9/20/12	10/17/12	20
23.2	Solar Collector	Jace, Jerry	10/18/12	12/6/12	36
24	Final Project Release (End of Fall Semester)	Brian, Stephanie, Jace, Jerry	12/7/12	12/7/12	



Design, Budget, and Timeline



Design, Budget, and Timeline



7. Conclusion

The goal of this project is to create an innovative method of harnessing energy, in the form of heat, from the sun. We intend to convert this energy into electricity using a heat exchanger and a sterling engine. Once the heat is mechanical energy, it will be converted to DC which will charge two 12 volt batteries. The two 12 volt batteries will then run a 300 watt inverter. This ingenious approach will prove to be challenging. It will require each group member to work independently and collaboratively, utilize previously learned information, and expand our technical competencies through research and development. The final goal of the project is to have the satellite mini-solar power station fully functional outside using natural sunlight.

8. Sources

8.1. SunMachine - http://wood-pellet-ireland.blogspot.com/2009/11/sunmachine-germany.html
8.2. SunCatcher - http://peswiki.com/index.php/Directory:Stirling_Energy_Systems
8.3. Schuco - http://www.spheralsolar.com/products/PowerFilm-3V-22mA-Flexible-Solar-Panel.html and http://myfreeenergyblog.com/2499/schuco-solar-panels/.
8.4. Patents – http://www.uspto.gov/patents/process/search/
8.5. Stirling Engine - http://en.wikipedia.org/wiki/Stirling_engine
8.6. EMT - http://www.republicconduit.com/?id=235
8.7. SmartDraw - http://www.smartdraw.com/specials/smartdraw